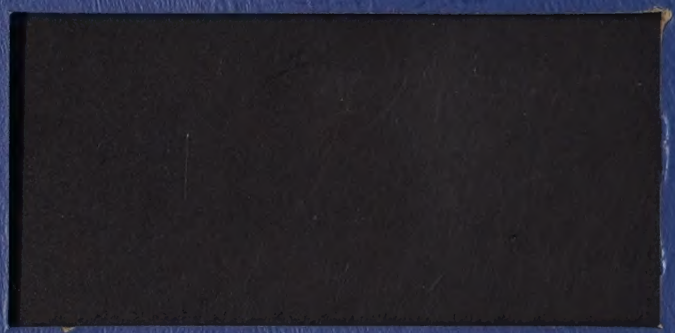
PRELIMINARY
INSTRUCTION MANUAL

FOR

DANA* MODEL 2718
DC LOG AMPLIFIER

DANA



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PRELIMINARY
INSTRUCTION MANUAL

FOR

DANA* MODEL 2718
DC LOG AMPLIFIER

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SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

The Dana Model 2718 DC Log Amplifier is a single-ended, non-inverting amplifier which delivers an output voltage equal to the log of the ratio of the input voltage to an internally generated reference voltage:

$$E_{out} = K \log_{10} \frac{E_{in}}{E_{ref}}$$

The amplifier is especially useful in amplifying unidirectional signals varying from very low to relatively high levels. Inputs up to 10 volts of either polarity (selected internally) are accepted by the amplifier. Input impedance is 10 kilohms. The unit delivers a full scale output of 5.301 volts at 10 milliamperes with short circuit limiting to 15 ma. No damage occurs with excessive loads of any duration.

1.2 SPECIFICATIONS

Configuration:	Single-ended, non-inverting with output common isolated from case and power ground in excess of 10^8 ohms at DC.
Transfer Function:	$E_{out} = K \log_{10} \frac{E_{in}}{E_{ref}}$
	where $E_{ref} = 5 \times 10^{-5}$ volts
	K can be set to $1 \pm 0.1\%$ by front panel scale control.
Accuracy:	± 1 db for 86 db down from full scale input level (86 db dynamic range). Useful to 106 db below full scale input level after re-zero.

SPECIFICATIONS (Cont)

Zero Control:	Sets output to 0 volts for internally generated $E_{ref} = 5 \times 10^{-5}$ volts. E_{ref} is selected by a front panel control. Zero resolution is $\pm$0.05 db.	
Bandwidth:	DC to 3 kc DC to 300 cps DC to 30 cps DC to 3 cps	

The above frequencies are switch selectable and are the -3 db points $\pm$20% in frequency. Limiting attenuation slope is -12 db/ octave above cutoff frequency. Minimum comeback attenuation is -60 db.

Settling Time: (3 kc bandwidth)	1 millisecond maximum to within 1 db of final value	
Input Characteristics:	Impedance	10 kilohms
	Full Scale	10 volts of internally selected polarity.
Output Characteristics:	Impedance	Less than 1 ohm DC to 1 kc
	Voltage	5.301 volts full scale
	Current	$\pm$10 ma
	Short circuit	limited to $\pm$15 ma (cannot be damaged by excessive or short circuit loads of any duration).
Stability:	$\pm$1 db for 40 hours after 30 minute warmup.	
Specifications:	apply for 12°C to 40°C ambient.	
Power:	115 volts $\pm$10%, 50 to 400 cps	
Size:	6 units to a 5-1/4" x 19" RETMA Standard Relay Rack Panel.	

SECTION 2

INSTALLATION AND INITIAL CHECKOUT

2.1 UNPACKING AND INSPECTION

The Dana Amplifier is shipped in a special reusable shipping package, designed to protect the instrument from excessive shock and vibration. Examine the package for signals of external damage before removing the unit. If external damage is present, notify the carrier before proceeding. Next, examine the outside of the amplifier for any evidence of damage due to excessive shock, vibration, water leakage, etc.

If the unit appears in perfect condition, proceed with the installation. However, if there is any apparent damage, communicate with the carrier for instructions.

2.2 POWER REQUIREMENTS

The amplifier operates from a 115 volt (±10%), single phase, 50 to 400 cps power source. Maximum power consumption is 4 watts. Power connections are identified under paragraph 2.3.

2.3 INPUT OUTPUT CONNECTIONS

All external terminals appear at the back of the amplifier case on a 15-pin male blade-type connector commonly used on circuit boards. The mating connector is a Cinch 252-15-37-170 or equivalent. Figure 2.1 shows all connections to the amplifier.

2.4 INITIAL CHECKOUT PROCEDURES

2.4.1 General

The amplifier is carefully inspected and accurately adjusted at the factory. The following procedures check the DC operation of the amplifier to verify proper performance. For equipment required for this checkout, see Section 5, paragraph 5.1.

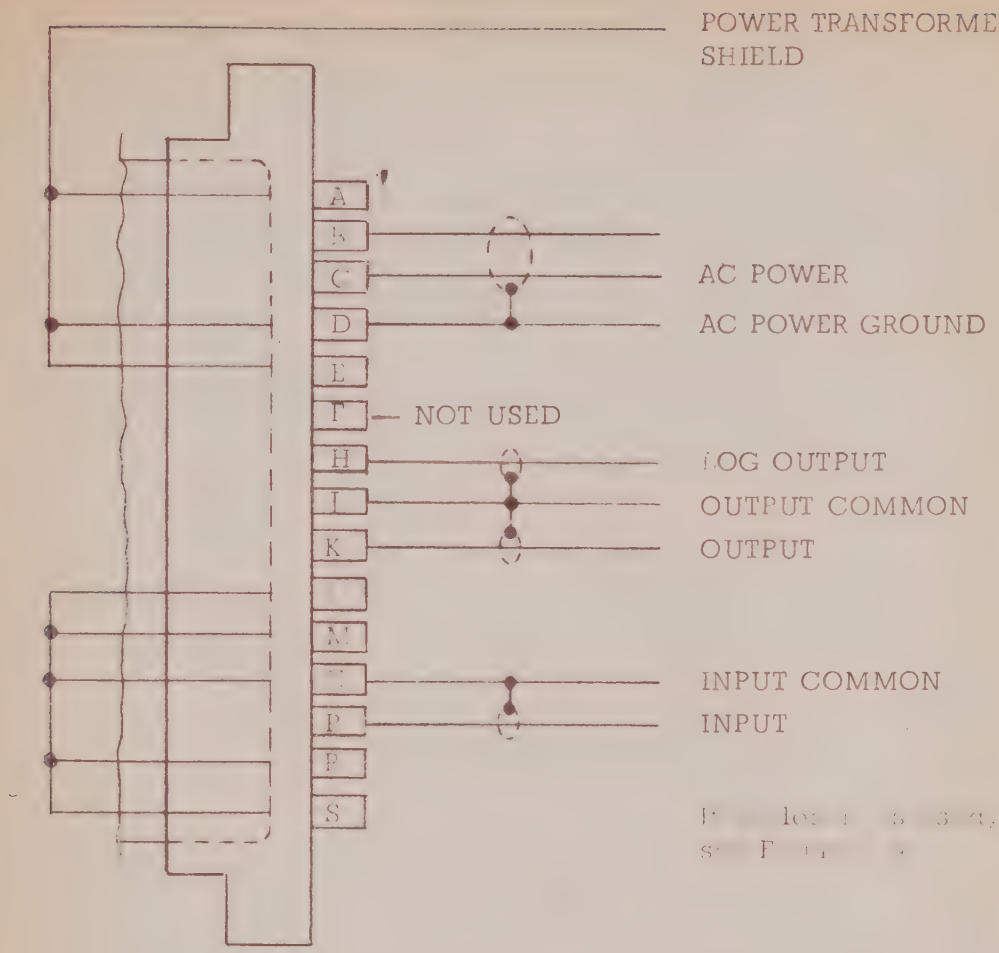


Figure 2.1 - Input/Output Connections

2.4.2 DC Operational Check

Using a precision DC voltage source, apply the voltages listed in the following table to input pins P and N. Check for the indicated output voltages at output pins K and J.

TABLE 2-1

INPUT	OUTPUT
10.000 V	5.3010 V ± 50 mv
5.000 V	5.0000 V ± 50 mv
500 mv	4.0000 V ± 50 mv
50 mv	3.0000 V ± 50 mv
5 mv	2.0000 V ± 50 mv
500 uv	1.0000 V ± 50 mv

2.4.3 Evaluation of Results

If the amplifier passes this test, it is highly probable that the amplifier is fully functional. A complete and critical test of each amplifier is made prior to shipment. The sort of damage that can be expected in shipment tends to produce gross malfunctions, not minor changes in such sensitive characteristics as gain or accuracy.

If the indicated results were not obtained from the checkout procedures, refer to the calibration procedures in Section 5.

SECTION 3

OPERATION

3.1 CONTROLS

The following controls and adjustments are located on the front panel of the amplifier.

3.1.1 BANDWIDTH Switch

This rotary selector switch selects the bandpass characteristic of the amplifier (-3db points). The following ranges are selectable:

DC to 3 cps
DC to 30 cps
DC to 300 cps
DC to 3 kc

3.1.2 SIG/CAL Switch

The SIG/CAL switch selects the input to the amplifier. The SIG position is used in normal operation and connects the external input signal to the amplifier. The CAL position applies the internally-generated reference voltage to the amplifier; this position is used for calibration and for checking amplifier operation. In CAL position, the amplifier output voltage is zero volts.

3.1.3 GAIN Adjustment

The GAIN potentiometer is a screwdriver adjustment used during calibration. It adjusts the gain of the filter amplifier and sets the value of K to 1 in the basic equation

$$E_{out} = K \log_{10} \frac{E_{in}}{E_{ref}} .$$

This potentiometer is adjusted during the calibration procedure and should not be varied unless recalibration is desired.

3.1.4 ZERO Adjustment

The ZERO potentiometer is a screwdriver adjustment on the front panel used during the calibration procedure. It sets the amplifier output voltage at zero volts with E_{ref} applied to the input (see Section 5, "Calibration Procedures").

3.2 STRAPPING ARRANGEMENT

Two sets of bifurcated terminals on the Log Amplifier circuit board must be strapped to prepare the amplifier for either a positive or negative input voltage. The terminals are initially strapped to accommodate positive input voltage. The physical location of these terminals is shown in Figure 3.1. Strap position 1 is for positive voltages. If negative inputs are expected, the straps must be moved to position 2.

Note

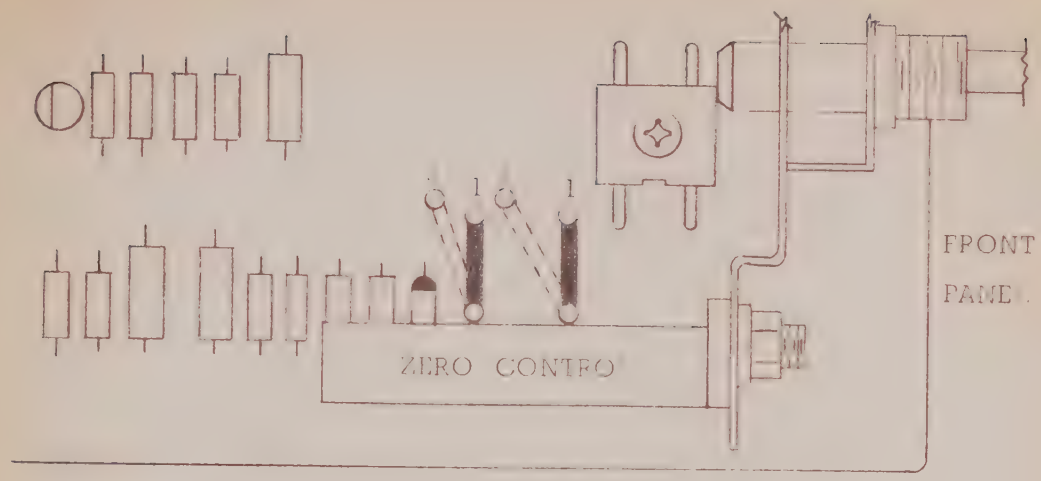
If the strap position is changed, recalibration of the amplifier is necessary. Refer to "Calibration Procedures," Section 5.

3.3 OPERATIONAL ADJUSTMENTS

Normally the amplifier is ready for use without performing operational adjustments. Stability is achieved within thirty minutes. A quick check of stability can be performed by placing the SIG/CAL switch into the CAL position and monitoring the output voltage for zero volts.

3.4 OPERATING PROCEDURES

The Dana amplifier is extremely easy to operate — requiring only proper input/output connections and the application of AC power as described in Section 2. The only manual operation is the selection of bandwidth by use of the BANDWIDTH switch.



STRAP POSITION NO. 1 FOR POSITIVE INPUT VOLTAGE.
STRAP POSITION NO. 2 FOR NEGATIVE INPUT VOLTAGE.
(TOP VIEW OF CIRCUIT BOARD SHOWN)

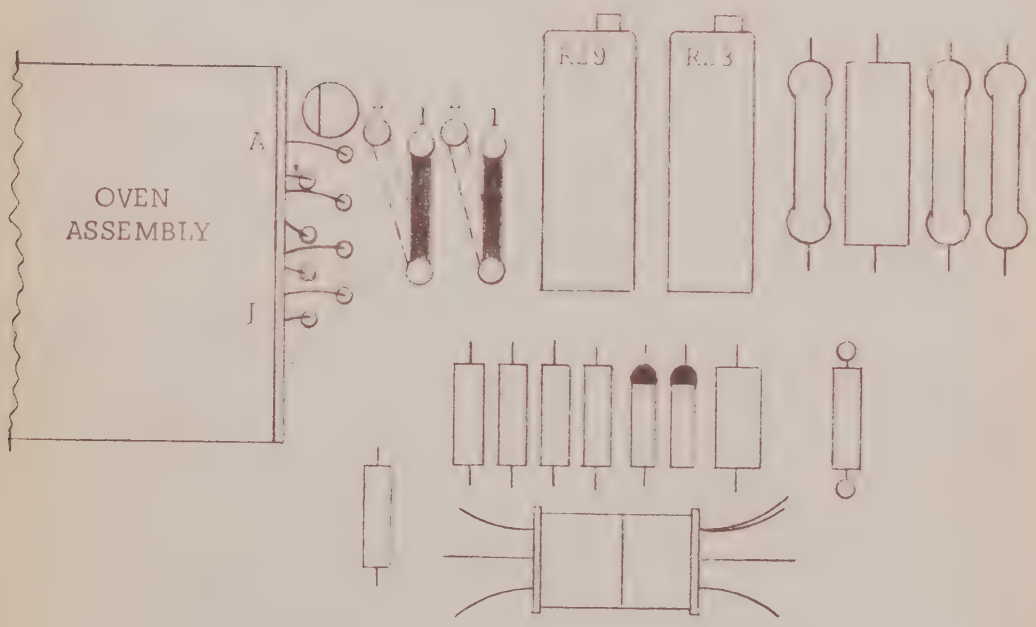


Figure 3.1 - Strap Locations - Log Amplifier Board

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

A simplified block diagram of the Dana Model 2718 amplifier is shown in Figure 4.1. It consists of two amplifiers each of which is located on a separate printed circuit board. The Log Amplifier is an operational amplifier which generates the log function. The Filter Amplifier provides the output voltage and contains switch selected filter networks to determine bandwidth.

4.2 LOG AMPLIFIER

The output voltage (E_2) of the log amplifier is logarithmically related to the input voltage (E_{in}). Input current (E_{in}/R_A) through the log diode generates a voltage across the diode which is the log of the input current. The log diode is enclosed in a component oven to maintain thermal stability of the voltage across the diode.

A switch at the input selects either the input voltage (SIG) or a 50 microvolt internally generated calibration voltage (CAL). The calibration voltage is taken from a zener diode-voltage divider circuit. In the CAL position, the output voltage of the filter amplifier is zero volts.

4.3 FILTER AMPLIFIER

The Filter Amplifier has a gain of approximately 15. Capacitors C_A, C_B and C_C determine the bandpass frequency (-3db cutoff) of the amplifier. A different set of capacitors is switched in for each frequency range selected by the BANDPASS switch (3 cps, 30 cps, 300 cps, or 3 kc).

4.4 STRAPPING ARRANGEMENT

Two sets of bifurcated terminals on the Log Amplifier circuit board must be properly jumpered to prepare the amplifier for either positive or negative input voltage. Strapping of one set of terminals selects the polarity of the feedback diode of the Log Amplifier (see Figure 4.2A).

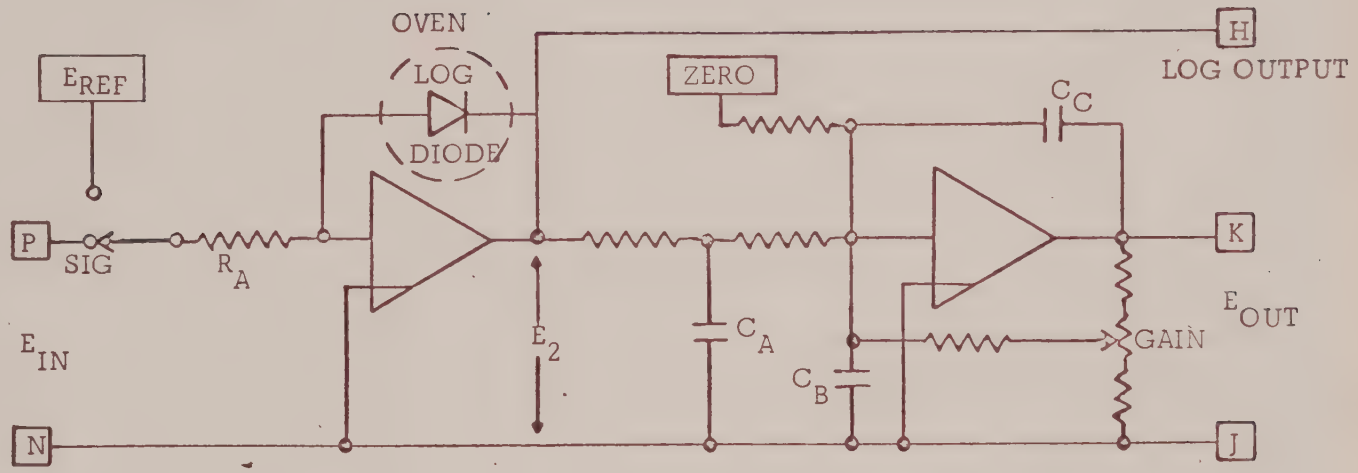


Figure 4.1 - Model 2718 DC Log Amplifier
Block Diagram

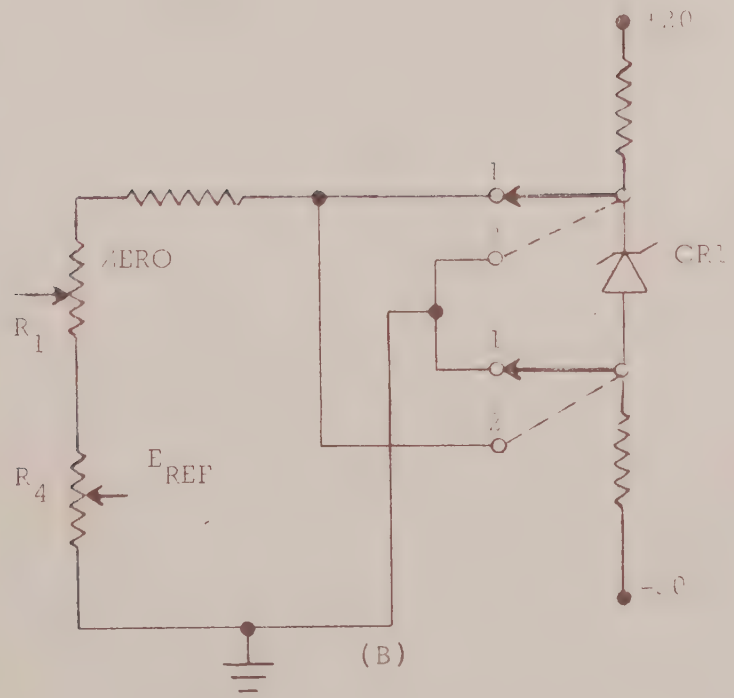


Figure 4-2 - Stabilization Functions

For positive input voltage, the straps are connected to the terminals marked 1. For negative input voltages, the straps are connected terminals marked 2 (dashed lines). The result is reversed polarity of the diode.

The other set of terminals is strapped to select the polarity of the internal reference voltage (Figure 4.2B). The reference voltage is taken from zener diode CR1. For positive inputs, strapping is to terminals marked 1. For negative inputs, strapping is to the terminals marked 2. The result is reversed polarity across the ZERO potentiometer (R1) and across the reference voltage adjustment potentiometer (R4). The amplifier is initially shipped with the terminals strapped for positive input voltage. If these are changed for operation with negative inputs, the amplifier will require recalibration.

4.5 POWER SUPPLY

The power supply is a full wave diode bridge rectifier with series transistor regulation circuits. Equality of the positive and negative 20 volt supply is maintained by zener diodes in the regulator circuits.

SECTION 5

CALIBRATION

5.1 TEST EQUIPMENT

The test equipment used to calibrate Dana Amplifiers is laboratory type equipment. This type of test equipment is not available in some facilities. For example, all voltage readings are taken on a Dana Digital Voltmeter. If another type of voltmeter is used, the accuracy of the meter must be taken into consideration. Below is a list of the test equipment used by Dana Laboratories. These items, or their equivalents, constitute the recommended test equipment list:

Dana Digital Voltmeter
Medistor A-60C Microvoltmeter
Dekavider
Cord Set
Batteries

5.2 TRANSFER FUNCTION ACCURACY TEST

The following procedures are performed with the polarity straps connected for positive voltage input.

(a) Put amplifier on cord set and connect to test equipment as shown in Figure 5.1.

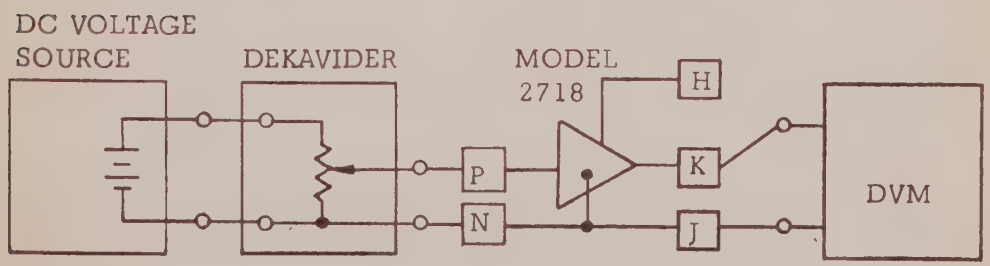


Figure 5.1

(b) Set BANDWIDTH switch to .003; set SIG/CAL to SIG.

(c) Allow 30-minute warm-up period.

(d) Vary input voltage and check for output voltages as listed in the following table:

TABLE 5-1

INPUT	OUTPUT
+10.000 V	5.301 V ± 50 mv
+5.000 V	5.000 V ± 50 mv
+500 mv	4.000 V ± 50 mv
+50 mv	3.000 V ± 50 mv
+5 mv	2.000 V ± 50 mv
+500 μv	1.000 V ± 50 mv
+50 μv	0.000 V ± 200 mv

(e) Set SIG/CAL switch to CAL. Check for same output (±10 mv) as read for 50 μv input of step (c). If not within ±10 mv, but all voltages in step (d) are within specification limits, proceed to 5.6.

Note

If the amplifier outputs are within the tolerances specified in (c), the amplifier is in calibration.

5.3 LOG AMPLIFIER ZERO

(a) Connect voltmeter leads to Log Amplifier output pins H and J.

(b) Set SIG/CAL switch to SIG.

(c) Open input leads (P and N) on cord set.

(d) Adjust R29 (the base current potentiometer) for -100 mv at Log Amplifier output.

(e) Short input leads P and N.

(f) Adjust R23 (collector potentiometer) for as near zero as possible.

(g) Repeat steps (c) through (f) until both readings are zero + 250, - 175 mv.

5.4 GAIN ADJUSTMENT

(a) Set SIG/CAL switch to SIG.

(b) Apply 5.000 volts DC to input pins P and N.

(c) Connect voltmeter to output pins K and J and record voltage reading.

(d) Change input voltage to 5.000 millivolts.

(e) Connect voltmeter to output pins K and J and record voltage reading.

(f) Subtract the voltage reading in step (e) from that of step (c). If the difference is 3 volts $\pm$ 3 mv, the Filter Amplifier gain is set correctly. Proceed to 5.5.

(g) To correct a voltage output reading of less than 3 volts $\pm$ 3 mv, turn GAIN adjustment clockwise; if voltage is greater than 3 volts $\pm$ 3 mv, turn GAIN adjustment counterclockwise. Repeat steps (c) through (f) until output voltage is 3 volts $\pm$ 3 millivolts.

5.5 ZERO ADJUST (ENTIRE AMPLIFIER)

(a) Apply 5.000 volts DC to input pins P and N.

(b) With voltmeter, measure output voltage at pins K and J.

(c) Adjust ZERO potentiometer (R1) for output voltage of 5.000 volts $\pm$ 1 millivolt.

(d) Upon completing the above adjustments, repeat the Transfer Function Accuracy Test. If the amplifier output voltages are not within the specified limits, proceed to 5.6.

5.6 REFERENCE VOLTAGE ADJUSTMENT

(a) Remove top cover.

(b) Set SIG/CAL switch to CAL.

(c) Connect a microvoltmeter from the wiper of the SIG/CAL switch to output common (a convenient connection to common is the negative side of C3, .0047 µfd capacitor, located next to R4).

(d) Adjust R4 for a 50 microvolt reading.

5.7 FILTER AMPLIFIER ZERO

(a) In order to perform this step, it is necessary to partially disassemble the amplifier. Remove power from amplifier. Remove the right side rail (as viewed from the front) and the Log Amplifier printed circuit board from amplifier base.

Figure 5.2 shows the intraconnection between the circuit boards and identifies the location of all components referred to in the calibration procedures. Detailed component identification is provided by the board assembly drawings in Section 6.

(b) Disconnect P3 from J3.

(c) Connect clip lead from outer lead of R1 (34K, lead nearest edge of board) to negative side of C16 (.015 µfd capacitor). This shorts the input to the Filter Amplifier.

(d) Apply power to amplifier.

(e) Set scope vertical sensitivity to 5mv/cm.

(f) Adjust R9 on Filter Amplifier board for zero output.

(g) Remove AC power.

(h) Remove clip lead; reconnect J3, and assemble amplifier.

(i) Repeat 5.4 GAIN ADJUSTMENT and 5.5 ZERO ADJUSTMENT.

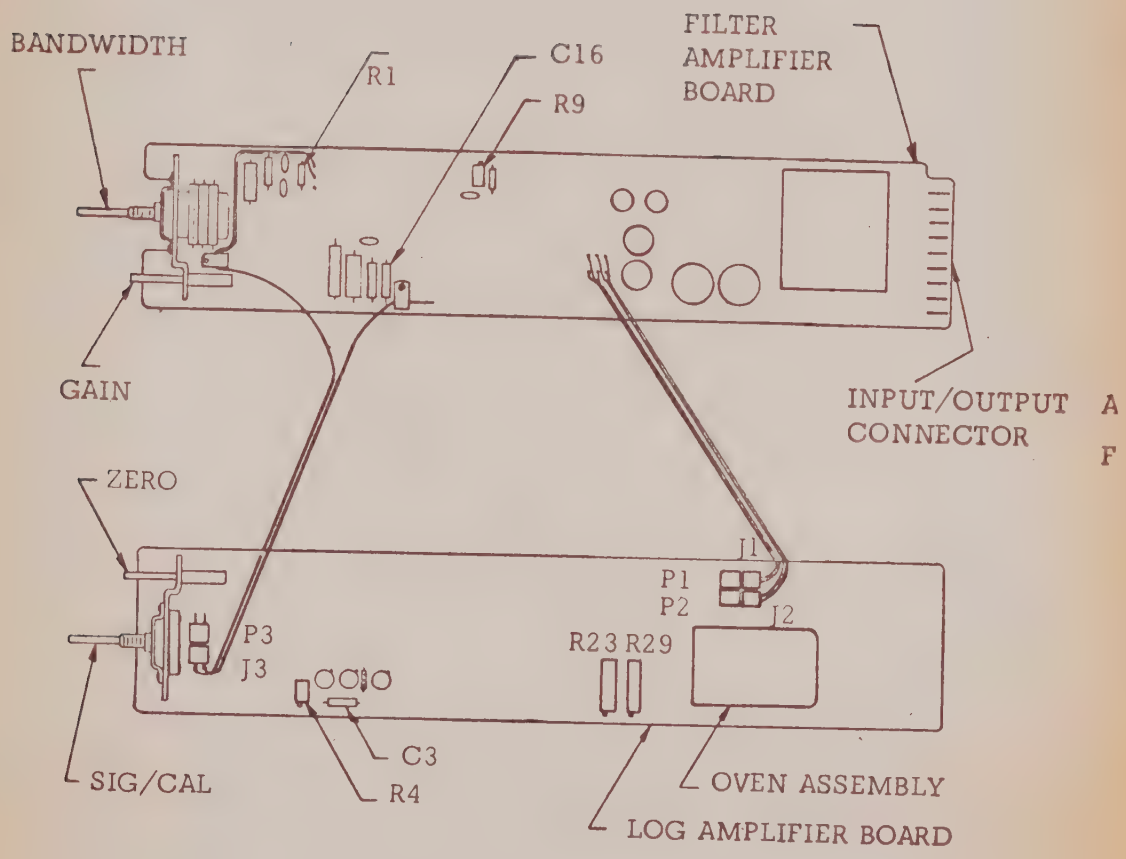


Figure 5.2 - Calibration Reference Locations

SECTION 6

SCHEMATICS

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